

THE DIAMOND POTENTIAL OF THE LATE CRETACEOUS ALTO PARANAIBA IGNEOUS PROVINCE, BRAZIL.

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The source problem. The identification of kimberlitic minerals (pyrope, perovskite, ilmenite) in the alluvial diamond deposits of the Alto Paranaíba region of Minas Gerais dates back to the end of last century and led to the recognition of kimberlitic rocks in the region two decades afterwards (Rimann, 1915). Such an obvious provenance link was, however, to be questioned for many decades to come, by the most influential Brazilian petrologist of that time, who dismissed the reported 'kimberlites' as mere basic alkaline rocks (Guimaraes, 1930). This long-lasting controversy was reignited in the last years with a new input of geochemical and mineralogical data and geotectonic interpretations. Supported on the work of Bizzi et al. (1994), Helmstaedt and Gurney (1994) and others, Gonzaga et al. (1994) claim that the region does not fulfill the geotectonic and geothermometric requisites to host primary diamond sources and that the region's diamond must have been transported by glacial events from remote Precambrian sources. Such conclusions are in conflict with our recent geothermobarometric data (Leonardos et al., 1995 and Carvalho & Leonardos, this conference) derived from mineralogical and geochemical studies of garnet lherzolite xenoliths. These xenoliths were recovered from the only available fresh outcrop of one (Tres Ranchos 4) of the few kimberlites that were reported to contain diamonds. They demonstrate the existence of a subcratonic diamond mantle source under the Alto Paranaíba region. Furthermore, the old problem of whether the Alto Paranaíba magmatism was of a shallow alkaline kamafugitic or of a deep kimberlitic nature was recently overcome through systematic geochemical and petrological studies (Gibson et al., 1995 a). In this work we were able to show that the Late Cretaceous (~85 m.a.) impact of the Trindade mantle plume under the Alto Paranaíba had generated different melts at a wide range of depths from varying mantle source composition: a) kamafugites representing high degree of partial melts from shallower clinopyroxene-rich sources. b) madupitic olivine lamproites representing melts derived from phlogopitized lherzolitic to harzburgitic sources. c) kimberlites representing melts from a deeper fertile garnet lherzolite source towards the base of the mechanical boundary layer.

Diamond distribution and occurrence. Alluvial diamond is ubiquitous in the whole of the Alto Paranaíba region of Minas Gerais and Goiás. For over two centuries the region has been famous for yielding large high-quality gemstones weighing up to 1,680 carats. The heterogeneous size distribution, the common presence of red-wine Cr-pyrope, picroilmenite and minor Cr-diopside among satellite minerals, the abundance of perfect

octahedral crystals with no sign of having suffering any transportation are among the characteristics of the Alto Paranaíba diamond province. These same characteristics lack in the alluvial deposits of the São Francisco craton derived from Precambrian sources. Not surprisingly, the rivers where panning has been more active are those like the Douradinho, Santo Antônio, Santo Ignácio, Bagagem, Quebra Anzol and the uppermost S. Francisco which drain numerous garnetiferous kimberlite sources. At the Romaria mine, diamond is hosted by Upper Cretaceous polyimictic conglomerates with intercalations of ultramafic tuffs and plentiful volcanic fragments accompanied by kimberlitic heavy minerals. These conglomerates have been deposited in a small rift from nearby sources (Fleischer, this conference) while the Alto Paranaíba volcanism was still active. Lack of diamictite fragments of the Ibiá Group suggests that this unit could hardly be responsible for the high diamond concentrations (up to $.25 \text{ ct/m}^3$) of the Romaria conglomerates. Only a primary source, like a kimberlite, in the immediate vicinities of the deposit could account for such a high diamond grade.

Diamond is indeed associated with the Alto Paranaíba Cretaceous magmatism. It has been reported in headwaters that have only drained ultramafic tuffs and associated pipes, it was formally documented as occurring within the Coromandel tuffs (Maack, 1968), within kimberlites of the Bambuí/Campos Altos district (Barbosa, 1991) and within the Tres Ranchos 4 pipe (Gonzaga & Tompkins, 1992). Kimberlitic microdiamond finds have also been reported by Canadian junior companies who have recently started exploration campaigns in the region.

Kimberlites. The abundance, distribution and mode of occurrence of the Alto Paranaíba kimberlites are poorly understood. Their volume is only a very small fraction of the kamafugitic rocks but they are abundant in several clusters within the region. The Tres Ranchos 4 pipe is the only kimberlite intrusion who has been assessed in terms of major and minor element chemistry, mineral and isotope chemistry and geothermobarometry. It is also the only garnet bearing (mostly G-9) ultramafic pipe which has been quantitatively assessed in terms of its diamond content. Estimates of the work done by SOPEMI S.A. are in the order of $.01$ to $.1 \text{ ct/m}^3$. This kimberlite was generated at depths greater than 200 km but it is not an insulated occurrence among the shallower kamafugitic intrusions. It belongs to the group of deeply weathered pipes with plentiful Cr-pyroxene, Mg-ilmenite, minor Cr-diopside and abundant relicts of garnet peridotite xenoliths, that though common in the Alto Paranaíba, have been omitted in most recent discussions about the region's diamond potential. These often occur as epiclastic sedimentary facies inside maar structures or as kimberlitic breccia of diatreme facies which are ordinarily buried at the bottom of the crater under a thick sediment cover. Examples of such garnetiferous kimberlites include pipes in the Tres Ranchos-Ouvidor-Davinópolis district, the Japocanga, Poço Verde, Vargem and Santa Clara pipes in the Coromandel district, the Boa Esperança and Cana Verde in the Bambuí district and the Casca D'Ánta-Vargem Bonita kimberlites in the Serra da Canastra. The common preservation of high level deeply weathered complex kimberlitic structures in the province, though enhancing its diamond potential,

makes diamond exploration costly and difficult. Lack of typical G-10 harzburgite garnets in the kimberlites does not make the region a classic terrain for large high-grade deposits. The diamond potential of garnet lherzolite sources cannot be, however, underestimated after the Argyle example. Associated in time and space with shallower kamafugite and carbonatite and with lamproitic rocks that might be formed above the diamond field, the off-craton Alto Paranaíba kimberlites, however, had their genesis under a thick continental lithosphere, compatible with a high diamond potential. Because of their non-classic geologic setting the APiP kimberlites may reveal important clues relative to diamond mineralization and genesis.

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